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Policy options and possible actions to expedite implementation: energy for sustainable development

Report of the Secretary-General

Summary

The present report highlights policy options and measures that could be taken at the international level with regard to improving access to energy, encouraging energy efficiency and promoting the use of advanced and cleaner energy technologies and other energy-related topics. Policy options and measures to encourage fuel switching from traditional biomass to modern energy services for cooking and heating are elaborated as a means for improving living standards, health and access to social services, including education, for women and children. A menu of policy options and possible actions to improve access to national electricity grids have been identified, including those aimed at lowering costs. Enhancing energy efficiency can reduce air pollution and regional and global atmospheric impacts as well as contribute to industrial development efforts. Policy options and possible actions to overcome market-related and institutional barriers to enhancing energy efficiency are identified along with ways to improve and transfer energy-efficient technologies. Strengthening the development and use of cleaner energy technologies also has a myriad of co-benefits including improving access to modern energy services, improving the way in which energy is produced and used, increasing industrial efficiency and reducing atmospheric emissions. Possible policies and measures with respect to renewable energy and cleaner fossil fuel technologies include technical standards, long-term collaborations and partnership arrangements as well as ways to achieve cost reductions.

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I. Introduction

1. At its fourteenth session, the review session of the second implementation cycle 2006-2007, the Commission on Sustainable Development conducted an evaluation of progress in implementing Agenda 21, the Programme for the Further Implementation of Agenda 21, decisions taken at the ninth session of the Commission and the Plan of Implementation of the World Summit on Sustainable Development (Johannesburg Plan of Implementation), while focusing on identifying constraints and obstacles in the process of implementation with regard to the current thematic cluster. This cluster covers the issues of energy for sustainable development, industrial development, air pollution/atmosphere and climate change. The report of the Commission on Sustainable Development on its fourteenth session[1] includes the Chairman's summary, which reflects the constraints and obstacles, and possible approaches and best practices for the implementation of those intergovernmental agreements, as well as the way forward identified by the ministers attending the high-level segment.

2. At its fifteenth session, the Commission on Sustainable Development will take policy decisions on practical measures and options to expedite implementation for the selected thematic cluster of issues, taking into account the discussions of the intergovernmental preparatory meeting, reports of the Secretary-General and other relevant inputs. The present report is a contribution to the Commission's discussions on policy options and possible actions to address the constraints and obstacles in the process of implementation identified in the report of the review session with regard to energy for sustainable development. The other issues of this thematic cluster and the cross-cutting issues identified at the eleventh session of the Commission are addressed in the relevant reports (E/CN.17/2007/3-6). Since the issues are interlinked, references to them are included in the present report.

3. The present report draws on a number of sources, including national reports and case studies submitted by Member States, the outcomes of regional implementation meetings and contributions of UN-Energy, major groups and secretariats of various United Nations convention bodies. As the four issues of this thematic cluster are closely linked, the relevance of these interlinkages for policy options is considered in the report on cross-cutting issues (E/CN.17/2007/6). Although the cross-cutting issues identified at the eleventh session are considered throughout the present report, many are addressed in the report on cross-cutting issues as well.

II. Access to energy

4. A combination of supportive policies at the national, regional and international levels, coupled with the commitment of necessary resources, could contribute significantly to providing access to modern energy services for cooking, heating and electricity in order to meet basic human needs and facilitate achievement of the Millennium Development Goals. At the national level, integrating and prioritizing energy-access policies for the poor into other policies and reflecting them in national sustainable development strategies, development plans and poverty reduction strategies has been shown to advance policy coherence and effectiveness.

[1] *Official Records of the Economic and Social Council, 2006, Supplement No. 9* (E/2006/29).

The experience of the Economic Community of West African States has shown that countries can cooperate regionally to give a high priority to energy access in their development plans and benefit mutually from harmonized policies and the sharing of energy resources. International support for technical assistance could be provided for the development of appropriate technical standards, planning and data gathering, and the design and implementation of financial instruments to support the development, expansion and/or refurbishing of electricity infrastructure.

5. A range of policy options and possible actions exist to lower the cost of extending grid access, bring down the cost of off-grid technologies and address the reliance on inefficient biomass cooking and heating, as the experiences of China and India show. The variety of conditions prevailing in rural areas and urban slums calls for a mix of policies and measures tailored to each case. In rural areas, possible actions include encouraging the use of modern fuels, such as kerosene and liquid petroleum gas. The adoption of simplified and low-cost transmission and distribution options in Tunisia and a focus on efficiency and economies of scale in South Africa have contributed to the success of electrification programmes in those countries. Successful programmes to extend the grid have been accompanied by policies that emphasize careful assessment, the setting of realistic goals and clear assignment of responsibility. Affordability can be addressed through policies that promote cost-sharing of grid access, such as using cross-subsidies, with a mixture of public finance, including donor grants and contributions from the beneficiaries. For certain types of consumers, such as poor households, connections could be partially subsidized.

6. A number of proven policies and possible actions are available to provide electricity access for stand-alone and mini-grid situations. Such policies and actions based on renewable energy sources could be particularly effective in small island developing States, as the experiences of Barbados and Cyprus have shown. In many countries, priority is given to electrifying such central points as clinics (for the refrigeration of medicines), schools, government offices and community centres. Targeted subsidies have been used to offset the high upfront cost of equipment, such as solar home systems. Related policy options include the promotion of local assembly and manufacturing, such as of solar water-heating systems, and allowing duty-free import of equipment and components. Measures and policies that strengthen community participation for the establishment, financing, operation and maintenance of decentralized electricity systems have been successfully implemented in a number of countries. A practical option in this regard is the establishment of rural energy funds or other financing mechanisms for the scaling-up of successful models for the provision of affordable, clean energy services, such as the rural electricity cooperatives that have been employed in Bangladesh. There is considerable scope for expanding existing international cooperation in relation to such technologies as minihydropower and biogas systems, in which certain developing countries lead the field, as well as building institutional and managerial capacity.

7. Lighting is an important issue for the rural and urban poor, not only with regard to extending hours of education and production but also for night-time pedestrian safety and such medical emergencies as child birth. Low-cost and energy-efficient lighting systems are available, such as solar lanterns and light-emitting diode and compact fluorescent lamp systems that can be powered by solar

energy. Programmes which make these technologies available to the poor could have a significant impact on the lives of poor women and children.

8. The experience of a number of developing countries has shown that rural energy policies can contribute more effectively to poverty alleviation if they facilitate income generation and the ability to develop micro- and small-scale industries. This implies that services need to be targeted at entrepreneurs and that suitable technologies need to be available. Examples of microenterprises providing energy services include battery and mobile phone charging services, small-scale agroprocessing and food preparation and the renting of solar lanterns. The multifunction platform that has been successfully employed in Mali provides affordable energy for milling, dehusking and water services, as well as for welding and battery charging. Nearly all of the clients are women.

9. In some developing countries, transmission and distribution losses are a major source of inefficiency in the electricity sector. Although technical losses can be minimized by the use of higher efficiency transformers and capacitors and the installation of improved control technologies, as well as the use of higher voltage lines, much of the loss is owed to theft and inadequate billing methods. Thus, a system that provides electricity to the poor would reduce the risk of unmetered electricity being accessed, and better metering and billing practices would improve the economy of electric power delivery.

10. Policies for the urban environment in developing countries generally address the affordability of clean, modern energy services. Slum upgrading and the associated provision of services offer an opportunity to increase access to modern energy services. Accordingly, appropriate policies and measures could be integrated into urban development planning, including by involving the utilities at an early stage. Government policies to regularize the rights of tenancy or occupancy, where legal title is unclear, have been shown to facilitate private investment and may encourage utilities to provide services. Policies to reorient existing subsidies from the general consumer to the poor consumer could also improve access, while also contributing to the financial viability of service providers. A policy option employed in a number of countries consists of providing a minimal amount of electricity at no cost or at a low cost through lifeline or graduated tariff rates, as is done in India and South Africa.

11. Cost and capacity constraints could be reduced by enhancing the enabling environment for small-scale suppliers of energy services that would include the installation and maintenance of equipment. In some countries, procurement for public works is geared to promoting the participation of small-scale providers and minorities. In several cases, loan guarantees have been employed to encourage private sector participation in providing energy services for the poor, including small-scale projects. These have been successful especially when undertaken in combination with training on ways to secure financing. Reducing risks faced by local entrepreneurs and banks/financiers could expand services available to communities. At the international level, as demonstrated by the experience of Egypt in the energy service company area, there is considerable scope for cooperation, sharing of experiences and assistance with respect to urban planning and electrification schemes. In recognizing the important responsibilities of municipal governments with regard to energy access, international organizations and international financial institutions could increase technical assistance to them.

Cooperative action could be undertaken through existing channels, such as the Slum Upgrading Facility of the United Nations Human Settlements Programme.

12. Where traditional fuels still dominate, the switch to more efficient modern energy services could be encouraged by lowering or eliminating taxes on more efficient modern fuels, with subsidies as an option to address affordability for the poor and the negative externalities generated by deforestation. Taxes on liquid petroleum gas and electricity ought to be avoided if they inhibit more affluent users from switching from fuelwood. Such policies could be especially important when energy prices are relatively high and discourage fuel switching to modern energy services. Targeted subsidies may be appropriate if they reduce the fixed costs associated with energy use, such as when applied to the purchase of cookstoves and other appliances, rather than lowering the recurring costs of fuels and electricity. Awareness-raising campaigns promoted through the health sector, in the media and in schools and undertaken with international and non-governmental organization support could assist in overcoming lack of technical and financial information on modern energy services and how they can be accessed.

13. Many of the policies geared to improving access to cleaner cooking and heating fuels are of particular benefit to women, who, along with children, are most likely to suffer from the health consequences of indoor air pollution and to spend time gathering fuel. In choosing from a menu of options, policies could be designed to ensure optimal co-benefits, including more time for child-rearing, increased economic opportunities and better access to health services and education. This context highlights the importance of integrating the concerns of women and children into overall energy planning and of linking access to energy for women with income generation and enterprise development opportunities. Budgeting processes that identify impacts according to gender and use needs assessments are tools that could be applied to ensure integration of these concerns. Training for women to become energy technicians and producers of simple energy technologies could increase the ability of women to contribute to energy-access solutions.

14. Some regions are endowed with considerable energy resources, but these may be concentrated in particular subregions or countries. Regional and cross-border cooperation can not only contribute to improving access to energy but also enhance energy security. Africa has abundant hydropower potential largely concentrated in the central areas, coal in the southern areas and oil and gas primarily in the northern areas and along the central Atlantic coast. Experience in other regions has shown that the development of cross-border energy infrastructure can assist in overcoming energy shortages, enhance industrial development and improve environmental performance. This approach is included in the New Partnership for Africa's Development with regard to energy trade. Thus, regional programmes to interconnect national power grids and jointly develop hydropower resources could contribute significantly to increasing access to electricity. Interconnection initiatives with power-sharing arrangements could also reduce the costs faced by small, fragmented power markets. The West African gas pipeline, for instance, will supply gas from fields in Nigeria (where some of it would otherwise be flared) to Benin, Togo and Ghana, replacing the more expensive and polluting oil currently used for power generation, and opening the opportunity to use compressed natural gas for vehicular transportation.

15. Many developing countries, including the least developed countries, could benefit domestically and regionally from the development and use of local gas deposits and of gas associated with oil production that have been considered uneconomical for the export market. An international arrangement to assist least developed countries in developing stranded natural gas reserves for local consumption is an option that could provide those nations with much needed energy, as well as economic and environmental benefits compared to currently deployed options.

16. International support can play a role in promoting access to energy by assisting developing countries, in particular least developed countries and small island developing States, in tapping infrastructure grant and loan facilities, providing technical assistance to State-owned energy enterprises and strengthening public sector firms that are active in the energy sector, as well as in designing effective public/private partnerships. Such support would facilitate concrete action, given the general consensus that the public sector will continue to be critical in the provision of the infrastructure needs of many developing countries, including to promote access by the poor to modern energy services. At the same time, good practices in the management of State-owned enterprises as well as regulatory and other reforms, including in relation to tariffs and subsidies, could ensure that the poor derive tangible benefits from increased public and private investment.

III. Energy efficiency

17. The co-benefits from implementing energy efficiency measures are numerous, including reduced costs, reduced energy demand, improved air quality and reduced greenhouse gas emissions. However, market-related and institutional barriers need to be overcome and improved energy efficiency technologies need to be made available to promote the adoption and use of energy efficiency measures. Greater international cooperation and further access to financing and technology transfer will be important for mobilizing energy efficiency investments in developing countries. Considerable scope exists for international technical assistance to assess and provide advice on opportunities to improve energy efficiency in all sectors, which could be coupled with concessionary or grant financing to implement recommended improvements.

18. Improving energy efficiency in industry and reducing local air pollution remain a major challenge at the national level, but a range of policy options exist that have successfully supported transitions to more energy-efficient economies in many countries. These options include benchmarking, energy auditing, negotiated agreements between Governments and industry, standards for more efficient motors, cogeneration for heat and power and using the by-products from industrial waste streams as inputs into other industrial processes. The potential for efficiency gains is particularly great in rapidly industrializing countries and in countries with economies in transition. Measures, such as benchmarking and partnerships for sharing expertise, have been employed in energy-intensive industries, including aluminium smelting and cement production. Cement production, which takes place in most countries, is particularly energy intensive, accounts for 5 per cent of annual global carbon dioxide emissions and can be a major source of local air pollution. As a programme of the World Business Council for Sustainable Development, the cement sustainability initiative, which was launched to improve performance in a

number of areas, including to reduce fuel use and emissions, could be a model for other energy-intensive industries.

19. In order to support implementation of many of these options, Governments could consider fostering the development of energy service companies to provide technical advice and related services. Experience in countries where energy service companies have been established has shown that they provide valuable technical advice and act as important promoters for industrial modernization, productivity gains and economic development. Experience has shown that providing financial support through partial loan guarantees to commercial lenders for energy service company projects and providing business development support to energy service company start-ups are practical measures that could be considered in establishing such service companies.

20. The modernization, rehabilitation and expansion of electricity sector infrastructure provide significant opportunities for achieving energy efficiency improvements. Possible actions, such as improved maintenance and upgrading, could bring about cumulative improvements in power plant efficiency. Switching to cleaner and more efficient technologies, such as cogeneration of heat and power, could yield large efficiency gains, while fuel switching from coal to natural gas could produce both energy efficiency and climate change benefits. Interconnection of national electricity grids into regional power pools is an option that might, for example, allow the sharing of the highly efficient hydropower production of one country while at the same time greatly enhancing stability of supply for all interconnected countries. Regionally liberalized and expanded electricity trade could also realize energy efficiency gains through improved utilization of generating capacity, leading to reduced emissions.

21. Efforts to modernize the extraction and processing of hydrocarbons also offer opportunities for energy efficiency gains, in particular in the downstream refinery industries of countries with economies in transition. Given that many oil and gas producing and exporting countries require access to advanced technology to improve efficiency of extraction and refining processes, policies to facilitate investment and access to technology could contribute significantly to reducing greenhouse gases. The Global Gas Flaring Reduction Partnership of the World Bank is trying to confront the huge planning efforts and infrastructure investments needed to achieve significant reductions in gas flaring and venting. Possible actions that could be considered to support those efforts include dissemination of best practices and capacity-building.

22. Energy consumption in the transport sector is increasing rapidly, a trend that is expected to continue. A range of policy options and possible actions are available to develop and deploy cleaner and more efficient vehicles. On the demand side, policies and measures could be designed to influence consumer behaviour, for instance through vehicle fuel-economy standards, insurance pricing, vehicle financing or the imposition of higher taxes on less fuel-efficient vehicles and on gasoline. Policies such as public fleet procurement have been employed to accelerate market development of more efficient and cleaner vehicles, such as bus fleets operating on compressed natural gas. An important regulatory option is the setting of standards for vehicle fuel efficiency, which can have a major impact on transport energy consumption. Public-private research partnerships and initiatives that promote the introduction of fuel-saving tyres and decrease the cost of

lightweight, very strong carbon-composite materials for vehicle construction constitute practical measures for addressing efficiency in the transport sector.

23. Energy consumption in buildings has also been growing rapidly, with current construction methods and standards determining consumption for decades to come. Effective use of locally available insulation materials, use of natural daylight, energy efficient and natural ventilation and other measures could significantly reduce space heating, cooling and other operational costs in buildings. At the regional level, the European Union has adopted a directive on the energy performance of buildings that requires its member States to implement a range of provisions aimed at improving energy performance in residential and non-residential buildings, both new and existing. Possible options for improving energy efficiency include policies for building codes and design standards and best practices guidelines. In many cases, such policies are adopted at the local or municipal level, based on model codes and taking into account the availability of building materials and prices, local climatic and soil conditions and other factors. In several countries, programmes offering incentives for retrofitting existing buildings, certification schemes and public awards for distinguished architects, designs and "green" buildings have contributed significantly to awareness of the economic advantages of energy efficiency. These may also be applicable in small island developing States to improve energy efficiency in the tourism sector.

24. Creating increased awareness of the long-term advantages of energy efficiency and promoting cooperation among architects, policymakers, municipalities, building developers, owners and tenants is a further practical measure that could increase the energy efficiency of the built environment. One option for achieving this is through active energy efficiency partnerships and international cooperation among concerned professional associations, municipalities, city officials and other energy policymakers. International technical assistance could be provided to help in the elaboration of appropriate technical standards, model building codes and best practices guidelines in developing countries and in countries with economies in transition. The Marrakech task force on sustainable building and construction could be one useful vehicle for international sharing of experience and best practices.

25. The significant benefits that can be achieved by programmes supporting the introduction of energy-efficient appliances, lighting and equipment are becoming widely known and are stimulating market demand for such products. An array of policy options and possible actions, such as minimum energy performance standards, negotiated agreements between industry and Governments, and demand-side management activities focusing on, among other things, introduction of such efficient lighting products as compact fluorescent light, have all proven to be effective tools for reducing electricity consumption and greenhouse gas emissions. Well-designed energy efficiency labelling schemes help to inform consumers, thereby facilitating the selection of sustainable products. Another matter for possible action that is beginning to receive the attention of policymakers is standby power consumption. In this regard, the 1-watt initiative of the International Energy Agency, which brings together equipment manufacturers, policymakers and other stakeholders to reduce standby power consumption to an acceptable minimum, provides an option for all stakeholders.

26. Efforts to facilitate international trade in energy-efficient products could greatly benefit from expanded international cooperation in the harmonization of

energy efficiency testing protocols. Technical assistance for the establishment of testing laboratories, whether at the national or regional level, could be a complementary practical measure. International partnerships, such as the collaborative labelling and standards programme and the efficient lighting initiative, as well as new "communities of practice" such as the compact fluorescent light initiative, a similar initiative for consumer electronics, and the Standards for Energy Efficiency of Electric Motor Systems initiative, are ongoing actions that could benefit from support and serve as models for possible actions to increase the energy efficiency of consumer products.

IV. Cleaner energy technologies

27. Strengthening the development, use and transfer of cleaner energy technologies, especially renewable energy and advanced energy technologies, is crucial to improving access to modern energy services, to improving the efficiency with which energy is produced and used and to significantly reducing atmospheric emissions. In fact, in addition to improving industrial productivity, a major drive for developing and deploying cleaner energy technologies is the need to reduce the emission of atmospheric pollutants, in particular greenhouse gases, that contribute to climate change.

28. A major problem with most of the cleaner energy technologies is cost. Together with increasing the scale of deployment, research and development are essential tools for reducing this cost. Thus, an important policy involves support for research and development of cleaner energy technologies. For potentially important technologies that appear to require long periods of development, international partnerships and public-private partnerships could accelerate development as well as permit a broader sharing of the resulting technology. A policy that supports education in science and technology can ensure the necessary technical capacity to participate in the development and application of these new technologies.

29. For the well-established cleaner energy technologies, the key to accelerating their deployment lies with lowering their cost. There are two approaches to achieving the necessary cost reductions, namely, increasing the scale of deployment so as to reduce unit cost through economies of scale, and conducting further research and development to decrease the cost of production and/or to improve system performance. Most of the policy options and possible actions considered in section IV of the present report are expected ultimately to contribute to achieving cost reductions.

30. The equipment, infrastructure and skills necessary for the deployment of these technologies do not exist in many developing countries. Therefore, combating climate change and reducing air pollution calls for long-term collaboration between developed and developing nations in advanced energy technologies, including through capacity-building and technology transfer.

31. While the deployment of renewable energy technologies for off-grid applications is an important option for providing access to modern energy services in remote areas and small island developing States, it is their large-scale deployment for grid power that will make a significant contribution to a diversified energy mix and to a reduction in greenhouse gas emissions. The large-scale deployment of renewable energy technologies has been promoted by such policy instruments as tax

credits and favourable feed-in tariffs. It is important that these instruments be stable and predictable. Those countries that have enacted legislation to promote the use of renewable sources of energy, such as by establishing a minimum proportion of energy to be produced from renewable sources, and that have established tariff and other regulations for grid-connected electricity have been successful in accelerating the deployment of these technologies. China and many countries of the European Union offer examples of success in this regard. Tradeable renewable energy credits, combined with renewable energy portfolio standards, can be a relatively low-cost policy option for promoting wider adoption. The dissemination of many of the technologies, in particular for power from wind and solar energy, could be further advanced through the sharing of experiences and lessons learned in addressing environmental and aesthetic concerns. Technical, operational and regulatory standards for grid integration owing, inter alia, to the intermittency of resource availability, could also be elaborated in the framework of international cooperation.

32. The transformation of biological feedstocks into fuels is of growing interest with regard to both expanding fuel supplies and providing cleaner fuels. The primary biofuels currently produced are ethanol, as a substitute for gasoline, and plant oil products that can substitute for diesel fuel. With biofuels being of interest as alternate fuels in all countries, including in small island developing States, there is some expectation that they could be produced for export by agriculture-based developing countries, although there are concerns about restrictive trade practices. While the availability of the land needed for producing biofuels can also be an issue, some of these fuels can be produced from waste biomass. Now that national and/or regional associations to promote biofuels have been formed on every continent, one option to accelerate the switch to these fuels is support for a forum where Government policymakers and technical experts can share their experiences with these fuels and seek assistance in the development of national biofuel strategies that cover the needed regulatory and policy framework, infrastructure and investments. Building on the experience of and support from India, West African countries are utilizing the jatropha plant for biofuel production and looking at innovative ways to leverage financing for increasing production.

33. While tapping renewable sources is effective in reducing greenhouse gas emissions, the limited scale of deployment of renewable energy technologies to date necessitates continued extensive reliance on fossil fuels. There are three approaches to reducing greenhouse gas emissions, while maintaining the same energy delivery from fossil fuels, namely, promoting: (a) advanced and cleaner fossil fuel technologies that improve energy efficiency and/or produce reduced emissions; (b) a switch to fuels that emit less carbon dioxide, such as natural gas and the biofuels mentioned above; and (c) the deployment of technologies for capturing and storing or reusing the carbon dioxide emitted by power plants.

34. The deployment of advanced, cleaner and more efficient fossil fuel technologies could be facilitated by arrangements that would make available to many producer countries advanced oil production and refining technologies and advanced clean coal technologies, such as supercritical pulverized combustion and integrated gasification combined cycle plants. One type of arrangement, including partnerships with developing countries in the development and deployment of those technologies, is an option that could expand the market for the technologies and thereby reduce unit price.

35. Options for promoting natural gas include the development and expansion of liquid natural gas projects and the development and deployment of gas-to-liquid technologies, such as will be used in the facilities under development in Qatar. Other options relate to supporting projects to construct gas pipelines and to using natural gas associated with oil reservoirs that is currently being flared, such as is being undertaken by the Global Gas Flaring Reduction Partnership of the World Bank.

36. All the individual elements needed for carbon dioxide capture and storage systems have been demonstrated, and the next step towards commercialization involves the construction of integrated full-scale demonstration plants. Carbon dioxide capture and storage is critical for fulfilling coal's potential to provide continued low-cost electricity in developing countries as concerns over carbon dioxide emissions grow. Since such power plants cost significantly more than standard coal-fired power plants, deployment could be facilitated by supportive policies and the results of further research and development. There are fewer than two dozen countries that rely heavily on coal as an energy source, including several large industrialized and developing countries. Policy options and possible actions for accelerating the capture of carbon dioxide are those that could facilitate and support arrangements among these countries for sharing technology and know-how to retrofit, where feasible, existing coal-fired power plants and to deploy plants with built-in carbon dioxide-capture capability. For example, the FutureGen Alliance is a public-private international partnership established to demonstrate the option of zero-emission coal-fired power generation, with associated production of hydrogen.

37. In addition to the policy options and possible actions concerning greenhouse gas emissions described in the report on climate change (E/CN.17/2007/5), carbon dioxide in large quantities is being considered as a resource for enhancing oil extraction. While the technique of injecting carbon dioxide has been in use for more than three decades to maintain production in mature oil fields, state-of-the-art developments of this technique are increasingly being considered and used as the number of mature fields expands. A partnership that would include representatives of major petroleum and carbon dioxide-emitting industries could promote and facilitate the rational use of carbon dioxide as a resource for enhanced oil recovery and for the eventual storage of that carbon dioxide in capped depleted oil reservoirs.

38. As a major greenhouse gas, methane can be recovered and used as fuel. Thus, similar partnership options could be considered for expanding the deployment of the technologies used for the capture of methane from coal mines, oil production, landfills and such biological sources as peatlands and marshes. One example is the Methane to Markets Partnership, an international initiative that advances cost-effective, near-term methane recovery and use in order to reduce global methane emissions, enhance economic growth, strengthen energy security, improve air quality and improve industrial safety.

39. As concerns about climate change have increased, nuclear power generation, which produces no direct greenhouse gas emissions, is an option being considered by some countries. Although the choice of nuclear energy rests with countries, as recognized by the Commission on Sustainable Development at its ninth session,[2] there is continued public concern over the challenges with respect to safety, security,

[2] See *Official Records of the Economic and Social Council, 2001, Supplement No. 9* (E/2001/29).

spent fuel and radioactive waste management, and the proliferation of fissile materials. For those countries that choose nuclear energy, the International Atomic Energy Agency provides a forum for promoting international cooperation in the peaceful use of nuclear energy.

40. The primary option for technologies still under development is continued support for research, development and demonstration projects. Hydrogen energy technologies and fuel cells are technologies that fall into this category. The newly established International Centre for Hydrogen Energy Technologies of the United Nations Industrial Development Organization, in Istanbul, Turkey, and the International Partnership for the Hydrogen Economy, currently involving 16 countries and the European Community, provide options for accelerating the development and deployment of hydrogen energy systems. Hydrogen energy systems could be particularly effective in small island developing States that are endowed with such renewable sources of energy as geothermal energy and hydropower.

41. The increased use of cleaner energy technologies in developing countries could be facilitated by policy options and possible actions designed to promote trade in cleaner energy devices and systems, technology transfer agreements, support for national efforts to build organizational and manufacturing capacity, innovative financing and credit mechanisms and more involvement from the private sector. With regard to renewable energy technologies, local assembly and manufacturing of equipment could, under the right conditions, also lower costs and could be promoted by supporting national efforts to build organizational and manufacturing capacity.

42. The development agenda under discussion in the World Intellectual Property Organization could enhance the intellectual property rights framework pertaining to technology transfer, including clean energy technologies. Partnerships that involve developing countries in the development and deployment of advanced energy technologies could contribute both to the transfer of relevant technologies and the building of necessary capacities. They also could contribute to expanding the market for these technologies, with the added benefit of reducing production costs owing to economies of scale. An example of an international initiative to assist developing countries in a shift towards cleaner fossil-fuel technologies is the agreement between the European Union and China to cooperate in the construction of a demonstration coal-fired power plant that incorporates carbon dioxide capture and storage technology.

43. The sharing of technologies, especially through joint ventures, has proved to be an effective way of accelerating the use and transfer of cleaner energy technologies. An example is the Danish-Chinese joint venture to establish wind farms in China, which has helped to reduce the manufacturing cost per unit by increasing the scale of production. Moreover, by shifting the manufacture of the wind turbines to factories in China, a further reduction in unit cost was realized, local employment increased and China was able to join Denmark in entering the international market for this technology.

44. The technological strengths that exist in developing countries for a number of renewable energy technologies, such as the ethanol programme in Brazil, suggest that an opportunity exists for the establishment of a cost-effective South-South cooperation programme with international support to accelerate the deployment of these technologies for the provision of energy in other developing countries, in

particular the small island developing States and least developed countries. Other examples include the solar water heating technologies developed in Barbados and India, among other countries, and the biogas technologies of China and India.

45. Experience shows that dedicated financing agencies that seek external funds and make them available as loans for local renewable energy projects, such as the Indian Renewable Energy Development Agency, can accelerate the adoption of renewable energy technologies. Such agencies can also enable the leveraging of finance from domestic private-sector sources. Aside from financing, agencies of this kind can play an important role in facilitating and stimulating the market for renewable energy systems through measures such as renewable energy resource assessments and raising public awareness.

46. International and regional initiatives can contribute to accelerating the deployment and lowering the cost of cleaner energy technologies. Continued cooperation and discussions in regional forums would strengthen the exchange of experiences in the development and application of cleaner energy technologies among developing countries. Cooperative research and development programmes on cleaner energy technologies, including joint development projects, is a productive way of advancing the technologies, of adapting devices and systems to conditions in developing countries and of building local capacity. A number of partnerships and networks have been established which facilitate the sharing of information on these technologies, such as the "100% renewable energy islands" initiative. Consideration could be given to supporting implementation of General Assembly resolution 60/199 to promote new and renewable sources of energy by establishing a world renewable energy programme, similar to the recently concluded World Solar Programme 1996-2005, but potentially incorporating some of the options mentioned above, as well as by regularly evaluating available data to review progress being made in achieving the renewable energy goals contained in paragraph 20 (e) of the Johannesburg Plan of Implementation.

V. Policy options and possible actions at the international level

47. **The policy options and possible actions that can be considered at the international level to support implementation efforts for energy for sustainable development include:**

Increasing access to modern energy services

(a) **Increasing the engagement of countries at the regional level, including through the establishment of regional policies, to give a high priority to energy access in their development plans, with international support for such regional activities as efforts to interconnect national power grids;**

(b) **Utilizing microcredit schemes for users of modern cook stoves, and for cooking and heating fuels;**

(c) **Expanding initiatives by development partners and international financial institutions to strengthen financial markets in order to assist in designing and issuing financial instruments to support the development, expansion and/or refurbishing of the electricity infrastructure;**

(d) Supporting efforts to enhance technical capacities in State-owned energy enterprises;

(e) Supporting the establishment and strengthening of energy service companies through capacity-building;

(f) Increasing support for national efforts, such as financing with cross-subsidies, to provide electricity services to rural areas, including off-grid power based on renewable sources;

(g) Considering international arrangements which would assist least developed countries in the development of small local natural gas reserves and infrastructure for domestic use;

Improving energy efficiency

(h) Increasing the support of development partners and international financial institutions for existing programmes which benchmark and share expertise, in particular in energy-intensive industries;

(i) Increasing international support for national efforts to adopt standards and labelling for energy-efficient appliances, lighting, motors and consumer equipment, as well as harmonization of international testing methods;

(j) Increasing support for information exchange and expanded capacity-building on legal and regulatory frameworks to promote energy efficiency;

(k) Providing further support for the World Bank Global Gas Flaring Reduction Partnership;

(l) Expanding multi-stakeholder partnerships to enhance concrete collaboration to improve energy efficiency in transport;

Strengthening the development, use and transfer of clean energy technologies

(m) Supporting information-sharing activities and providing technical assistance for the development of national biofuel strategies in developing countries, including small island developing States;

(n) Increasing technology cooperation programmes, with international support, to accelerate the diffusion of renewable energy technologies, such as in the areas of solar photovoltaic and thermal energy, wind power, small-scale hydropower, geothermal energy, mini-hydropower and biogas, including through South-South cooperation;

(o) Implementing General Assembly resolution 60/190 to promote new and renewable sources of energy by considering the establishment of a world renewable energy programme, similar to the recently concluded World Solar Programme 1996-2005;

(p) Considering the establishment of a mechanism for regularly evaluating available data to review progress being made in achieving the renewable energy goals of paragraph 20 (e) of the Johannesburg Plan of Implementation;

(q) **Strengthening technology cooperation on advanced clean coal and carbon dioxide capture and storage technologies, including establishing cooperative partnerships to assist the major coal-consuming countries that are not members of the Organization for Economic Cooperation and Development to facilitate the transfer of the advanced, clean coal technologies needed to significantly reduce current and future air pollution and, to a lesser extent, carbon dioxide emissions.**